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CERTIFICATE OF TRANSMISSION BY FACSIMILE (37 CFR 1.8) Applicant(s): Charles N. Archie			Docket No. FIS920010090US1
Application No. 09/902,374	Filing Date July 10, 2001	Examiner Johnston, Phillip A.	Group Art Unit 2881

Invention: METHODOLOGY FOR CRITICAL DIMENSION METROLOGY USING STEPPER FOCUS MONITOR INFORMATION

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PRE-APPEAL BRIEF REQUEST FOR REVIEW

Docket Number (Optional)	FIS920010090US1
Application Number	09/902,374
Filed	July 10, 2001
First Named Inventor	Charles N. Archie
Art Unit	2881
Examiner	Johnston, Phillip A.

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Applicant requests review of the final rejection in the above-identified application. No amendments are being filed with this request.

This request is being filed with a notice of appeal.

The review is requested for the reason(s) stated on the attached sheet(s).
Note: No more than five (5) pages may be provided.

I am the

- [ ] applicant/inventor.
- [ ] assignee of record of the entire interest. See 37 CFR 3.71. Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)
- [X] attorney or agent of record. Registration number 43,029
- [ ] attorney or agent acting under 37 CFR 1.34. Registration number if acting under 37 CFR 1.34 ______

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October 6, 2005
Date

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

- [ ] *Total of ______ forms are submitted.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of:
Charles N. Archie

Serial No.: 09/902,374

Filed: July 10, 2001

Group Art Unit: 2881

Examiner: Johnston, Phillip A.

Atty. Docket No.: FIS920010090

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Mohammad S. Rahman

For: METHODOLOGY FOR CRITICAL DIMENSION METROLOGY USING STEPPER FOCUS MONITOR INFORMATION

PRE-APPEAL BRIEF REQUEST FOR REVIEW

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This pre-appeal brief request is being submitted together with a notice of appeal and is in response to the Office Action mailed July 26, 2005, setting a three-month statutory period for response. Therefore, this request is timely filed. Claims 1-26 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Su (U.S. Patent No. 6,388,253), in view of Tanaka, et al. (U.S. Patent No. 6,616,759) hereinafter referred to as "Tanaka". The Applicant respectfully traverses these rejections based on the following discussion.

The claimed invention, as provided in independent claims 1, 8, 10, 12, 19, and 20 contain features, which are not met by the prior art references of record. Specifically, claims 1 and 8 generally provide, in part, "...calibrating said image data by determining at least three best fit data parameters for improving a linearity of said image data... wherein said optimum critical dimension value comprises structural measurements of said critical dimension structure that are only relevant to a critical dimension of said critical dimension structure." Similarly, claim 10 generally provides, in part, "calibrating said image data by determining at least three best fit data parameters for improving a linearity of said image data ... wherein said optimum critical dimension value comprises structural measurements of a critical dimension structure that are only relevant to a critical dimension of said critical dimension structure." Likewise, claims 12, 19, and 20 generally provide, in part, "...calibrating said data by determining at least three best fit data parameters for improving a linearity of said data... wherein said optimum critical dimension value comprises structural measurements of said critical dimension structure that are only relevant to a critical dimension of said critical dimension structure." Generally, the claimed invention teaches a method to improve and optimize the accuracy of the CD-SEM measurement that relies on either additional information in the waveform or other information coming from

another distinct CD-SEM measurement or from another distinct non-CD-SEM measurement.

Conversely, Su assumes that the basic CD-SEM CD measurement is adequate for process control and thus forms the basis for process control. As such, Su does not seek to improve or optimize the CD value. Su tends to focus on how to directly determine stepper focus and dose conditions by directly comparing target waveform to reference waveforms. As such, Su does not explicitly teach how to use additional waveform information to obtain a more accurate CD measurement. Tanaka discloses a technique for controlling and/or monitoring a semiconductor processing apparatus while predicting its processing results, and thus even if combined with Su, would still fail to teach all of the elements of the Applicant's claimed invention.

The Office Action (page 4) admits that Su fails to teach all of these elements, but nonetheless concludes that Su when combined with Tanaka teaches all of these elements. However, a closer reading of Tanaka reveals that Tanaka does not teach what the Office Action purports it teaches, and thus even if it were combined with Su, the prima facie case for rejecting the Applicant's application is deficient and improper. In fact, Tanaka does not remove "structural bias parameters" from an approximate critical dimension measurement. The Office Action (page 5) indicates that Tanaka uses a best fit analysis in order to improve the linearity of the data. However, the Office Action assumes that Tanaka's removal of faulty process shapes is patentably analogous to Applicant's improved linearity. In fact, such a conclusion is erroneous. Rather, col. 2, lines 31-37 of Tanaka provide that Tanaka's technique monitors the processing state of a semiconductor process/apparatus to detect faulty processing or predict the processing based on the monitored results in order to improve the process. Conversely, Applicant's invention generates an optimum critical dimension value based on the three best fit data parameters in combination with a stepper focus parameter. Accordingly, the Applicant asserts that the Examiner is improperly combining Tanaka with Su and is making assumptions (i.e., Office Action states, "It is implied herein...") regarding Tanaka in an effort to try and teach the Applicant's claimed invention. Furthermore, there would simply be no motivation to combine Su with Tanaka because one of ordinary skill in the art would not have made the assumption (i.e., see implied language on page 5 of the Office Action) that was made in the Office Action.

Applicant's claimed invention teaches combining a stepper focus parameter with an approximate critical dimension (CD) measurement and (at least three) best fit data parameters. Conversely, nowhere in Su is it taught that an optimum CD value can be generated by combining stepper focus with an approximate (i.e., less than optimum) CD value and at least three best fit parameters used to improve the linearity of the CD data. In fact, combining the stepper focus with CD data as suggested and implemented by Su <u>will not</u> achieve optimum CD values. <u>This is because Su assumes that the CD value is already optimal. However, in fact, it is not optimal, as experimental results indicate.</u> According to column 3, lines 52-57 through column 4, lines 1-11 of Su, CD measurements are taken and are compared with design dimensions. If there is a deviation between the CD measurements and the established design dimensions, then Su corrects the deviation by adjusting the stepper dose. <u>Thus, in Su no changes or adjustments are made to the critical dimension measurement (i.e., no improvement (optimization) is made to the critical dimension measurement).</u> Conversely, in the claimed invention an improvement (optimization) is made to the critical dimension measurement by combining the stepper focus parameter with the critical dimension measurement. In other words, Su changes the stepper dose parameter to

reduce the deviation of measured parameters from design dimensions to achieve process control rather than combining the stepper focus parameter with the CD measurement to generate an improved CD measurement. As such, these (claimed invention compared with Su) are two fundamentally distinct inventions.

Page 2 of the Office Action states that Su discloses "obtaining a focus exposure matrix..." and "performing an analysis of the data to generate a 'golden waveform'." However, the Applicant's claimed invention claims no such features. Thus, the Office Action erroneously reads these features into the Applicant's claimed invention; therefore the rejection is improper.

Generally, Su (1) uses a reference CD value (which it assumes is optimal, when in fact it is not optimal); (2) measures a CD value; (3) compares the reference CD value to the measured CD value; and performs an etch process according to the difference in the reference CD value and the measured CD value. Conversely, the Applicant's claimed invention is basically challenging the validity of the reference CD in Su, which is taken as an optimum value. As such, the Applicant's claimed invention provides an analytical approach of optimizing the CD value by using at least three best fit parameters in combination with a stepper focus parameter to improve the linearity of the approximate CD data (i.e., reference CD data).

There exist many other fundamental differences and patentable distinctions between the claimed invention and the teachings of Su as well. Specifically, Su teaches how to control a lithography manufacturing process by using SEM (scanning electron microscope) waveform information and SEM CD (critical dimension) measurement to provide feedback and feedforward to dynamically tune lithography and etch processes. Conversely, the Applicant's claimed invention provides how to make a significantly more accurate CD measurement by correcting the initial (old) CD measurement by using lithography-defocus-sensitive information either from the CD or from some other source and combining this with the best fit data parameters in an analytical as discussed above. Additionally, what distinguishes the Applicant's claimed invention from the Su is the understanding that CD measurements inherent in Su are essentially corrupted due to consideration of structural characteristics, which are not relevant to the critical dimension, but which are highly sensitive to the stepper focus, such as sidewall angle, edge width, and profile grade (as clearly indicated in column 3, line 60 of Su).

Common to the patent of Su and the Applicant's claimed invention/specification is a body of work referenced in both, which teach that the printed feature has profile properties that can be sensitive to both lithography tool dose and focus settings. In some cases of the prior art, specialized targets are described that are particularly sensitive to defocus; i.e., measurements by optical or electron beam based tools provide defocus determination with much smaller uncertainty than what can be determined by using the waveform and CD from SEM measurement at a critical control feature. The work of Davidson et al. and Villarrubia et al. (referred to the Applicant's specification, page 7, lines 4-12) study the possibility of extracting printed structure profile information from the full SEM waveform. As Archie et al. (U.S. Patent 5,969,273) have taught, the sidewall information from the SEM waveform is a sensitive indicator of lithography tool defocus.

Su uses this prior art to teach a possible method for extracting stepper focus and dose

information, as well as sidewall information, from the SEM waveform for the purpose of providing corrective actions in manufacturing processes. However, and most significantly, Su does not teach how to improve (optimize) upon the critical dimension measurement itself as does the Applicant's claimed invention.

Achieving a more accurate CD measurement is an important application of the CD-SEM that is outside of the manufacturing control application. In particular, there are three main uses for the CD-SEM: (1) Process development, including lithography process development; (2) Manufacturing process control; and (3) Diagnostic measurements for an Out Of Control (OOC) manufacturing process.

Su clearly addresses only the second application (2) above. In that application where many manufacturing processes have been previously optimized and fixed, the dominant process variables that vary under normal circumstances act like stepper dose and focus variations. Only under these conditions is the process control method taught by Su a possible control strategy. Conversely, the Applicant's claimed invention addresses the other two applications (1 and 3 above) for the CD-SEM as well as providing a more accurate CD measurement for dispositioning of a product.

During process development many more process and design parameters can vary and highly accurate CD measurements are needed to understand the issues. This situation continues to worsen as lithography and etch processes evolve to produce ever smaller features. One example that has gained importance in recent years is the need to make accurate CD measurements of a variety of structure geometries at a variety of design sizes in order to develop accurate simulation models of the full lithography process. With an accurate simulation model, the chip design data can be modified (optical proximity corrections, sub-resolution assist features, phase shifting technology for the mask, etc.) to improve upon the printing fidelity (printed image versus pre-OPC (optical proximity correction) design data).

To make accurate critical dimension measurements to feed into the simulation model optimization or verification, the measurements must not be corrupted by secondary characteristic changes in the critical shape being measured. Particularly, profile changes caused by lithography focus-like variations should not be allowed to alter the base CD measurement. As such, the Applicant's claimed invention removes the profile-change-induced-errors in the measurement thereby revealing the design-induced-changes needed for simulation optimization or verification. This is accomplished by combining the stepper focus with a critical dimension measurement, which generates an optimum critical dimension. This use of the CD-SEM continues to grow as the industry starts to move away from CD-SEM as the principal tool for manufacturing control (application 2) toward scatterometry as the preferred metrology system for control.

It appears that the Office Action is contending that Su and Tanaka teach all of the elements of how to make a more accurate CD measurement. However, since Su's purpose is solely to teach process control and more precisely, a method to obtain more control of the final etch CD, Su does not describe how to make a more accurate CD measurement. Furthermore, Su teaches how to obtain a set of reference data by constructing reference data (CD, waveforms, and other data (see Figure 2B of Su) from specially constructed Focus-Exposure-Matrix wafers (see

Figure 1 of Su). However, attempting to match a target waveform to one of the reference waveforms and then reporting a CD result based on that match would provide too coarse a CD measurement, thereby teaching away from the claimed invention's method of producing an optimum CD value. Experimental testing as conducted by the Applicant, with the results provided and described in Applicant's Figures 2, 9, and 10 and associated text in the specification indicate that there are many problems with this type of prior art approach including the impracticality of constructing a large enough FEM wafer to reduce the coarseness and the issue how to exactly distinguish between similar reference waveforms. Similarly, Tanaka says nothing regarding combining three best fit parameters with a stepper focus parameter in order to generate an optimum critical dimension value.

Furthermore, the Applicant's specification further teaches that SEM resolution is a critical issue today and will only get worse in the future. Moreover, many details of the feature affect the critical portions of the waveform (see Figures 6A-6C of Su) including the bottom CD and many elements of the sidewall profile. Waveforms can differ because of changes in many of the feature properties but Su fails to teach how to weigh this information to extract the CD free of the secondary characteristics of the profile.

As such, the Applicant's claimed invention relies on the sophisticated CD methodologies already available on commercial CD-SEMs. These methodologies have been developed to overcome noise limitations in the waveform as well as to seek the bottom edge signature in the waveform. The claimed invention's approach is to provide a correction to that determination based on additional information possibly coming from analyzing the waveform in another way to gain stepper focus like information or if necessary using information from a separate measurement. As such, the claimed invention's approach does not suffer from either the coarseness problem or the resolution-limiting-convolution of multiple feature signatures in the waveform.

In view of the foregoing, the Applicant respectfully submits that the cited prior art references, Su and Tanaka, do not teach or suggest the features defined by independent claims 1, 8, 10, 12, 19, and 20 and as such, claims 1, 8, 10, 12, 19, and 20 are patentable over Su and Tanaka. Further, dependent claims 2-7, 9, 11, 13-18, and 21-26 are similarly patentable over Su and Tanaka, not only by virtue of their dependency from patentable independent claims, respectively, but also by virtue of the additional features of the invention they define. Thus, the Applicant respectfully requests that these rejections be reconsidered and withdrawn.

Respectfully submitted,

Dated: October 6, 2005

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